

Lipid chemistry

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Lipids



Syllabus

- CV-B-001 Lipids classification.
- CV-B-002 Functions of Lipids.

Properties of Lipids

- CV-B-003 Classification of Fatty acids:
role of saturated and unsaturated fatty acids, trans fatty acids ,mono and poly unsaturated acids in diet on lipid profile
- CV-B-004 Lipid peroxidation and its significance.
- CV-B-005 Biochemical and therapeutic role of eicosanoids,(prostaglandins, leukotrienes, thromoxanes and prostacyclins.

- ***Recommended reading material:***
- ***Lecture slides***
- ***Lippincott, Harper, Mushtaq***

Learning objectives

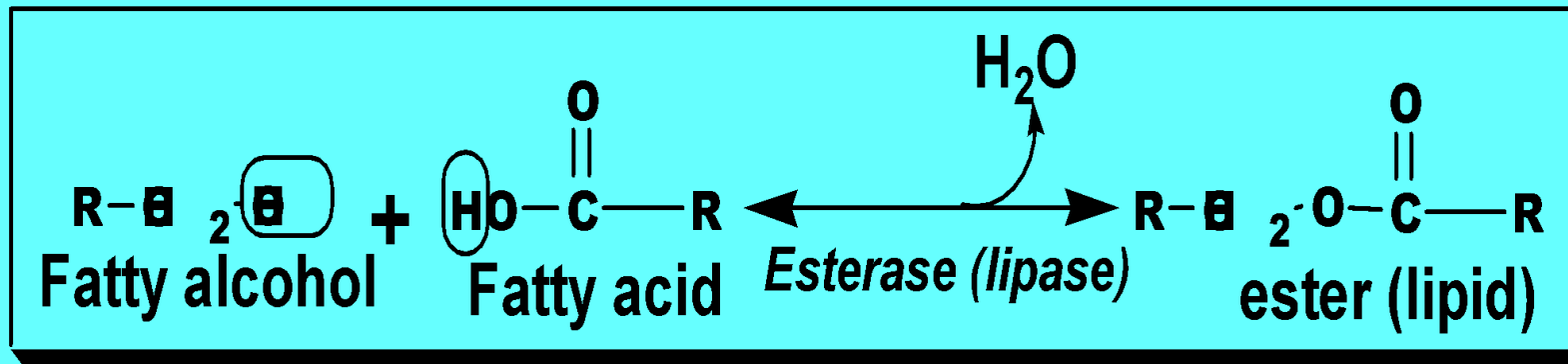
lec 1

- **CV-B-001 classify lipids**
- **What are lipids.**
- **Biological/biomedical importance**
- **Types of fatty alcohols.**
- **Nomenclature and classification of lipids**

Chemistry of Lipids

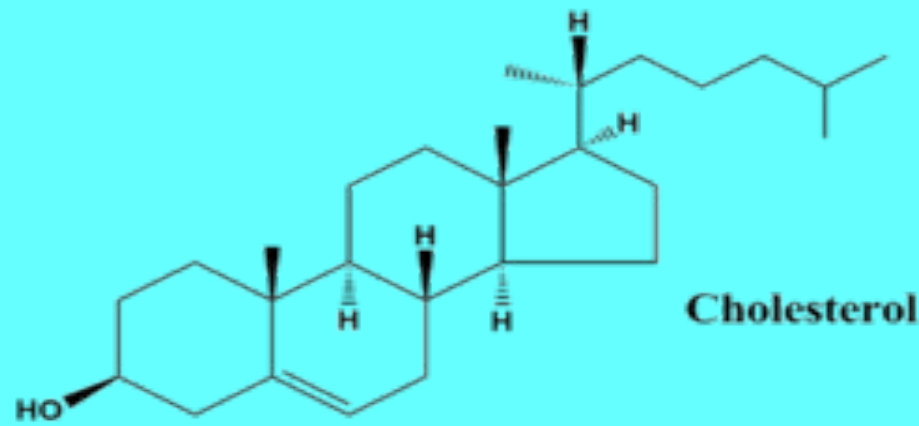
Definition:

- Lipids are organic compounds formed mainly from alcohol and fatty acids combined together by ester linkage.



What are lipids?

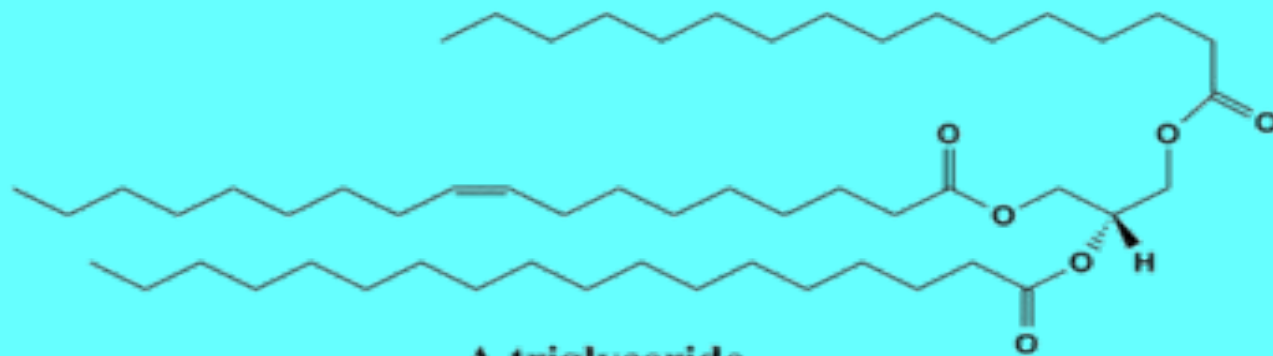
- Lipids are a heterogeneous group of substances, including **fats, oils, steroids, waxes, and related compounds**, which are related more by their physical than by their chemical properties.
- They have the common property of being relatively **insoluble in water but soluble in nonpolar solvents** such as ether and chloroform.



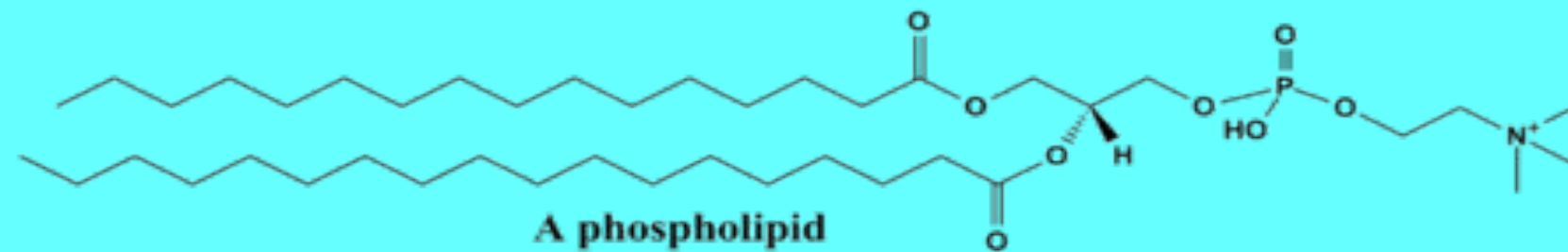
Cholesterol



A free fatty acid



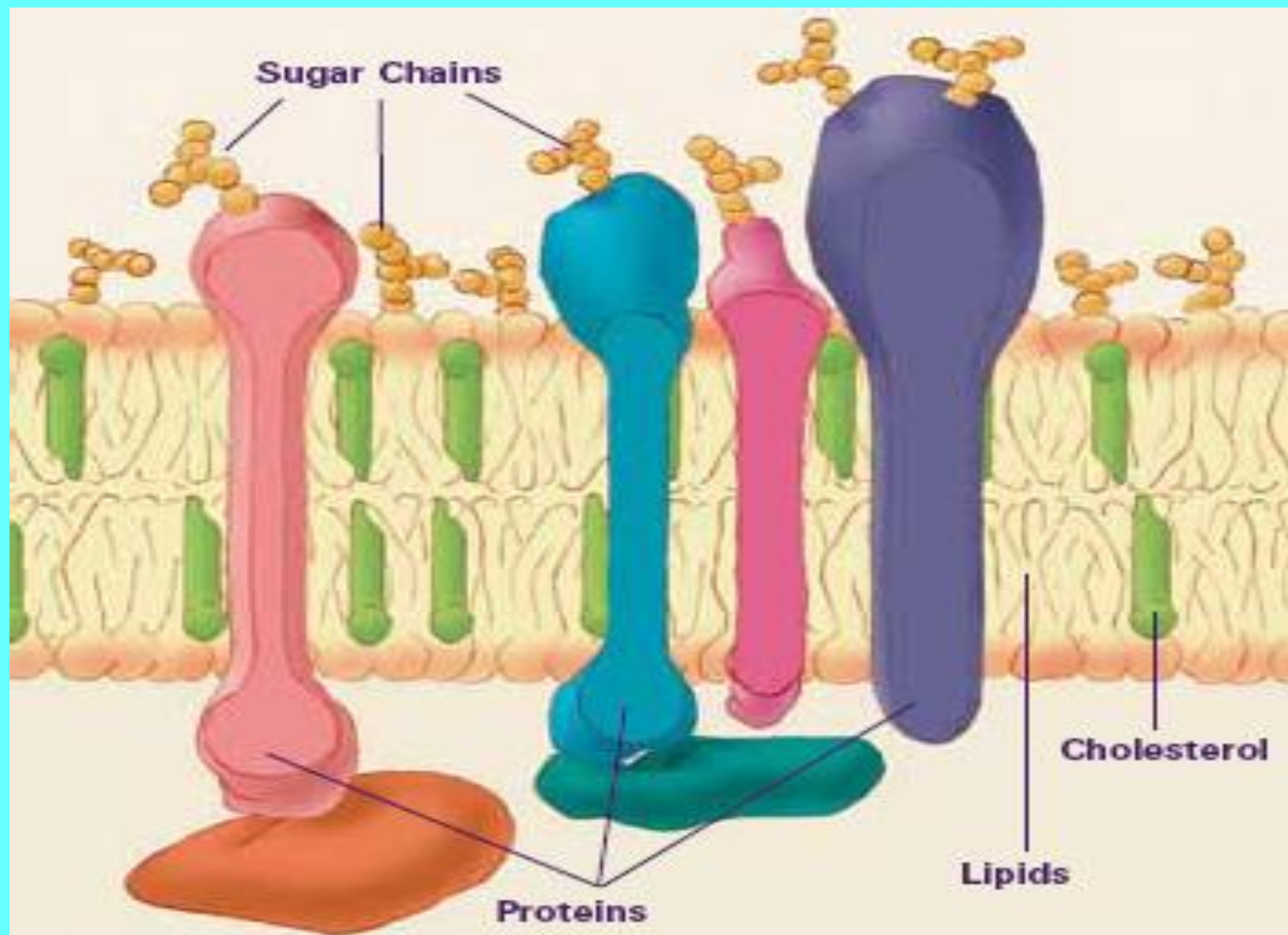
A triglyceride



A phospholipid

Biological Importance of Lipids:

- 1. Palatable and storable.**
- 2. High-energy value (25% of body needs)**
- 3. Essential fatty acids.**
- 4. Fat-soluble vitamins.**
- 5. Cholesterol Cell membrane and nervous system.**
- 6. Depot fat**



Clinical correlations

obesity

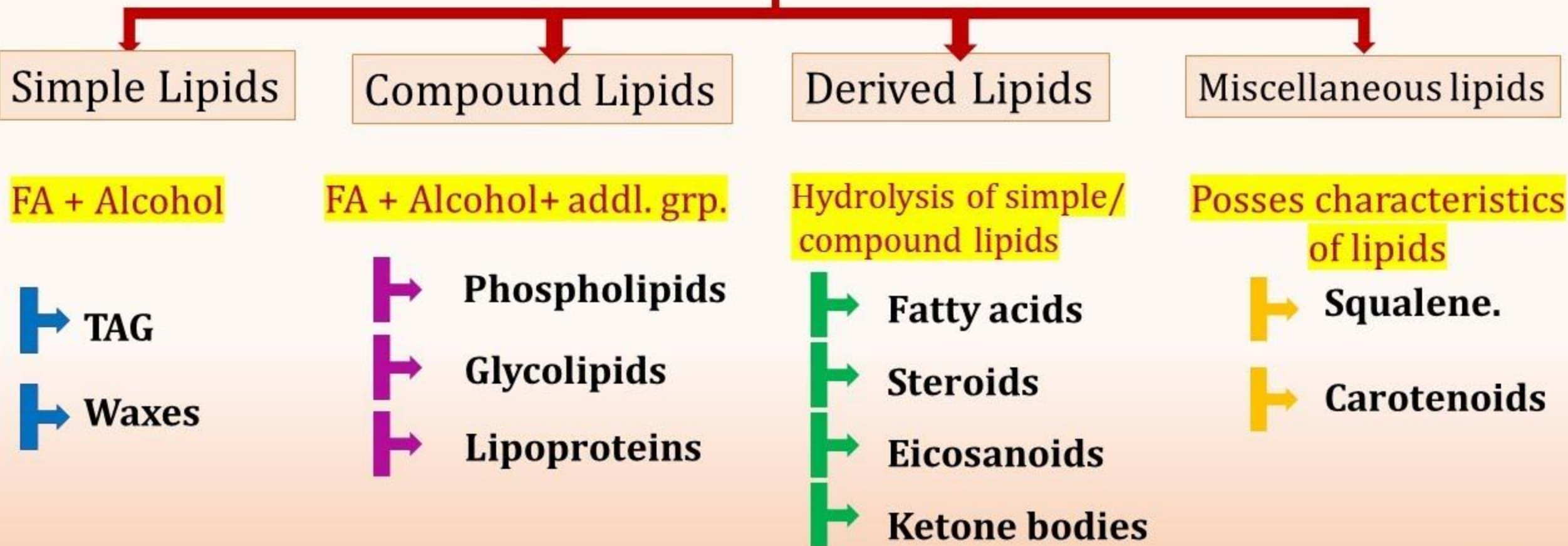
atherosclerosis

lipid-storage diseases

essential fatty acid deficiency

respiratory distress syndrome

Lipids: Definition & Classification



Classification of Lipids

- 1. Simple lipids (Fats & Waxes)**
- 2. Compound or conjugated lipids**
- 3. Derived Lipids**
- 4. Lipid-associating substances**

Complex lipids

- Esters of fatty acids containing groups in addition to an alcohol and a fatty acid.
- **Phospholipids**: Lipids containing, in addition a phosphoric acid residue.
 - glycerophospholipids the alcohol is glycerol.
 - sphingophospholipids the alcohol is sphingosine.

Complex lipids

- **Glycolipids (glycosphingolipids):**
containing a fatty acid, sphingosine, and carbohydrate.
- **Sulfolipids**
- **Aminolipids**
- **Lipoproteins**
- **Gangliosides**

Precursor and derived lipids

- **Fatty acids**
- **Glycerol**
- **Steroids**
- **Fatty aldehydes**
- **Ketone bodies.**
- **Lipid-soluble vitamins**
- **Steroid hormones.**
- **Eicosanoids**

Fatty alcohols

1-Glycerol:

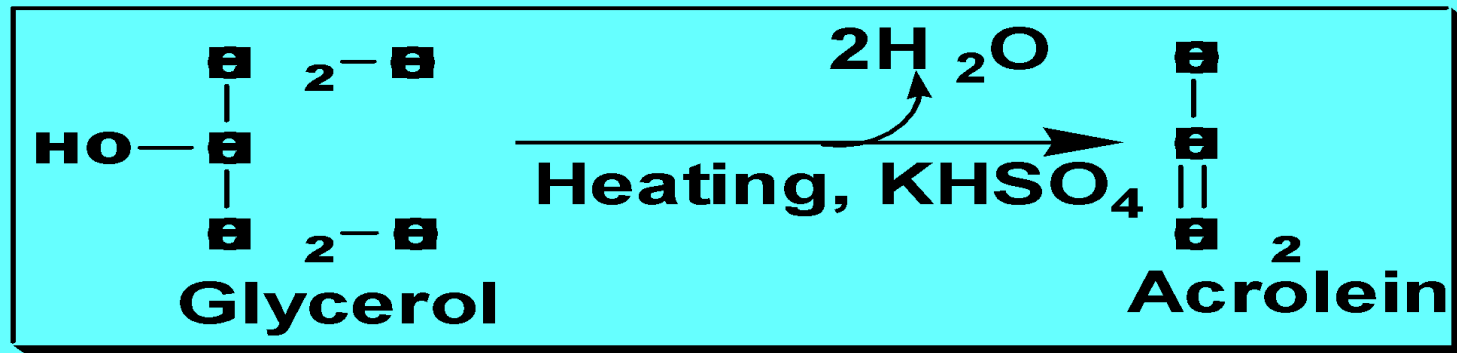
- It is a trihydric alcohol (i.e., containing three OH groups)
- Popular name glycerin.

GLYCEROL BASE



There are different triglycerides, depending on the side chains.

1. Colorless viscous oily liquid with sweet taste.
2. On heating with sulfuric acid or **KHSO₄** (dehydration) it gives acrolein that has a bad odor.



3- On esterification with fatty acids it gives:

- **Monoglyceride**
- **Diglyceride.**
- **Triglyceride**

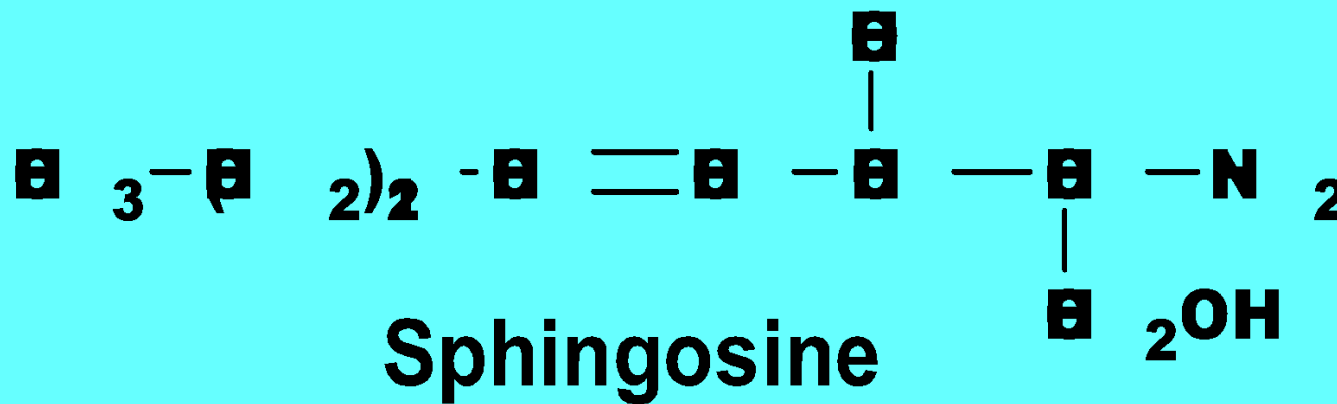
4- Substrate for gluconeogenesis

5- Structure of phospholipids.

6. Trinitroglycerin that is used as explosive and vasodilator.

2-Sphingosine:

- present in sphingolipids.
- synthesized in the body from serine and palmitic acid.
- It is not positive with acrolein test.



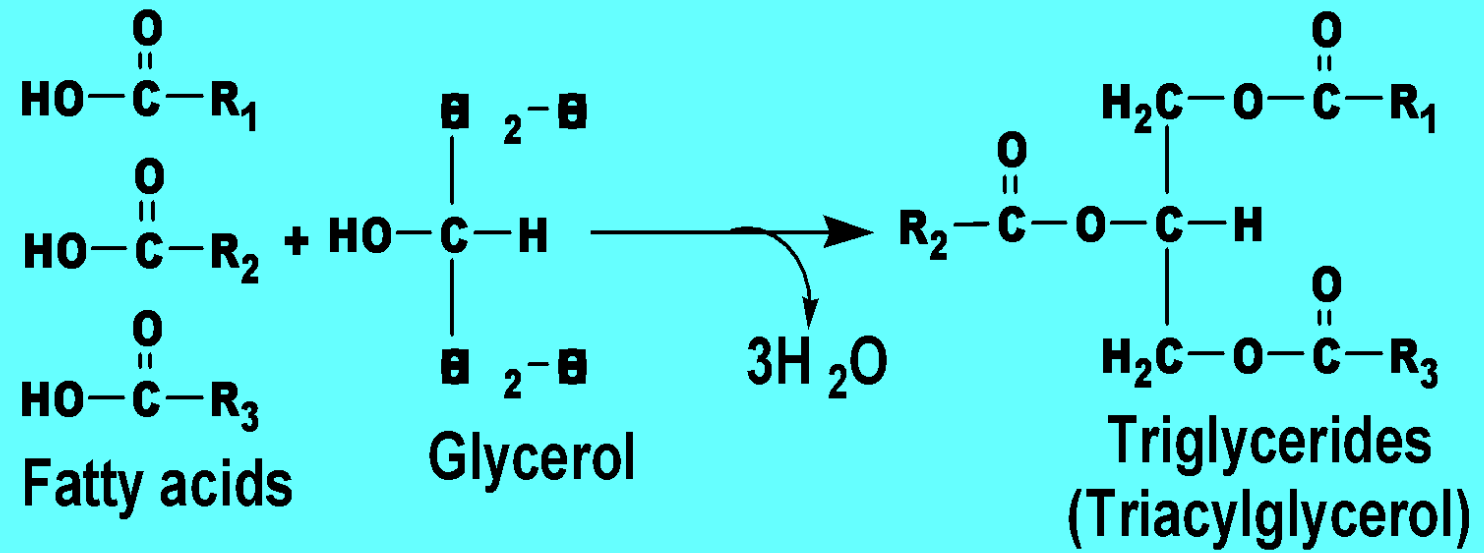
Simple lipids

- a. Fats:*** Lipids from animal sources are solid.
- b. Oils :*** fats from plant source are liquid.
- c. Waxes:*** Esters of fatty acids with long chain, higher molecular weight monohydric alcohols.

1-Simple Lipids

Neutral Fats and oils (Triglycerides)

- **Most abundant lipids in nature.**
- **98% of the lipids of adipose tissue.**
- **30% of plasma or liver lipids.**



Types of triglycerides

1-Simple triglycerides:e.g; tripalmitin.

2-Mixed triglycerides: e.g.,
palmito-oleo-stearin.

- *Natural fats are mixtures of mixed triglycerides with a small amount of simple triglycerides.*

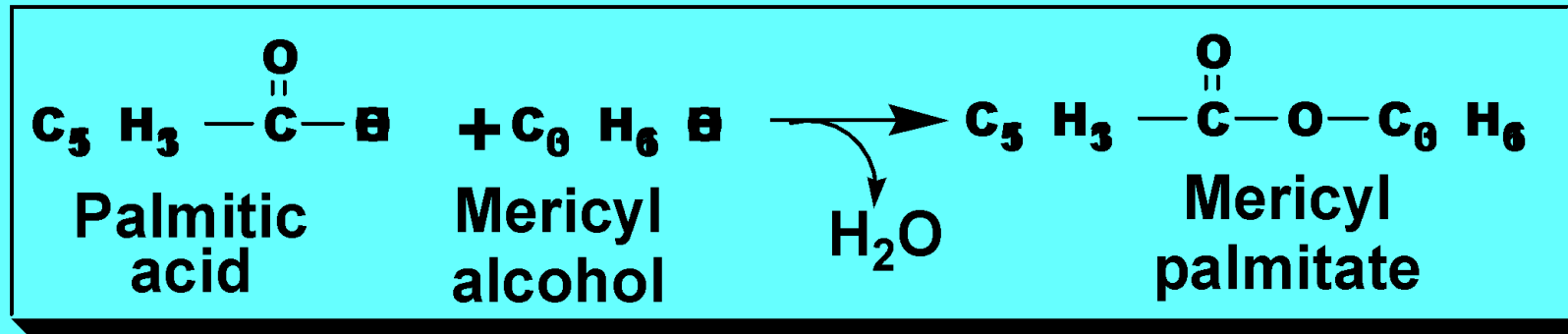
Type of Waxes:

A-True waxes:

beeswax

lanolin,

spermaceti



B- Non true waxes.

- Cholesterol esters
 - vitamin A and D.
-
- Properties of waxes:
 - Waxes are insoluble in water, but soluble in fat solvents.
 - *indigestible* by lipases and are very resistant to *rancidity*.
 - Thus they are of *no nutritional value*.

Differences between neutral lipids and waxes:

	Waxes	Neutral lipids
1.Digestibility:	Indigestible (not hydrolyzed by lipase).	Digestible (hydrolyzed by lipase).
2-Type of alcohol:	Long-chain monohydric alcohol + one fatty acid.	Glycerol (trihydric) + 3 fatty acids
3-Type of fatty acids:	Fatty acid mainly palmitic or stearic acid.	Long and short chain fatty acids.
4-Acrolein test:	Negative.	Positive.
5-Rancidability:	Never get rancid.	Rancidible.
6-Nature at room temperature.	Hard solid.	Soft solid or liquid.
7-Saponification	Nonsaponifiable.	Saponifiable.
8-Nutritive value:	No nutritive value.	Nutritive.
9-Example:	Bee & carnuba waxes.	Butter and vegetable oils.

2-Compound Lipids

They are lipids that contain additional substances, :

1. Phospholipids
2. Glycolipids.
3. Lipoproteins
4. Sulfolipids
5. amino lipids.

Phospholipids

___ phospholipids are composed of

1. Fatty acids.
2. Nitrogenous base (choline, serine, threonine, or ethanolamine).
3. Phosphoric acid.
4. Fatty alcohols.

Importance

- .
- 1. **Serve as primary building block for membranes.**
- 2. **They are important for synthesis, secretion and transport of lipoproteins. Thus, they are lipotropic agents that **prevent fatty liver**.**
- 3. **Myelin sheath of nerves is rich with phospholipids.**

4. They provide lung alveoli with **surfactants that prevent its collapse.**
5. Important role in signal transduction across the cell membrane.
6. They are source of polyunsaturated fatty acids for synthesis of **eicosanoids.**

STRUCTURE OF CHYLOMICRON

